RD&T
Brief

When to Apply Spring Load Limits?

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Roads are designed and built to support the weight of heavy trucks—up to a point. Road life is shortened and maintenance costs go up when vehicles carrying too-heavy loads travel on roads that can't adequately support their weight, causing cracking and rutting.

To protect flexible-pavement roads, Wisconsin has a year-round weight limit of 80,000 pounds gross weight with special overweight permits for log trucks up to 90,000 pounds. In mid-winter, when roads are frozen solid, a 98,000-pound limit without a permit takes effect. This allows trucks hauling logs, salt or winter abrasive to increase loads and take advantage of direct routes on secondary state roads, saving time and money.

In the spring, however, frozen pavements, bases and subgrades begin to thaw, soften and take on water, making them more vulnerable to damage. Temporarily reducing allowed loads during the spring thaw by as little as 20% (lowering the year-round 80,000-pound limit to 64,000 pounds) has been shown to increase pavement life by as much as 60%.

What's the Problem?

Knowing when to impose spring weight restrictions and when to lift them has been a perennial challenge, especially since WisDOT tries to make these decisions *two weeks in advance* to allow for adequate notification of highway users. Restricting truck weights longer than necessary may prevent farmers, loggers and others from legitimate use of the roadways. However, a late imposition of spring limits or premature return to normal limits raises costs for everyone if roads are damaged and require more repairs and earlier replacement.

WisDOT was concerned that available methods for determining the timing of weight restrictions (FHWA temperature method, frost tubes, pavement and subsurface temperature probes, and first-hand observation) were not sufficiently objective or uniformly applied. To address these concerns, researchers were asked to (1) assesses the effectiveness of current techniques and (2) develop a more objective and effective approach.

Research Objectives

The project was broken up into separate but related tasks:

- A survey and analysis of methods in use in Wisconsin and other states to determine timing of weight restrictions
- Measurement over two winter-spring periods of critical conditions at three different Wisconsin highway locations, including:
  - Climate data (temperature, humidity, wind speed, solar radiation)
  - Pavement condition data (frost depth, temperature, stiffness, water content)
  - Pavement performance data (surface and sub-surface stiffness)
- Development of a computer model to correlate climate and pavement data for the year in progress in order to *project* when to impose and lift weight restrictions

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Research team member Da-tong Jong with field monitoring equipment (powered by solar panels) and falling weight deflectometer (on trailer) for measuring highway layers stiffness.

"The computer model has been a valuable tool for us. The research is helping us move in the direction of data-driven decisions."

Tom Martinelli
WisDOT Bureau of Highway Operations

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Research Results

- The literature review revealed limitations and lack of agreement among the available methods for determining the timing of weight restrictions (FHWA temperature method, frost tubes, temperature probes and first-hand observation).
- Field collection of weather and road stiffness data over two winter-spring periods enabled development of a six-phase computer model integrating weather conditions, heat transfer, roadway stiffness, stress-strain effects, estimate of pavement damage and comparison to damage from normal loading in late summer.
- The MS Excel-based computer program UWFROST calculates equivalent damage load (EDL) for a given road 30, 60, 90 or 120 days into the future based on user-supplied average daily temperatures experienced in the year to date.
- Collected data and the literature review shows that full recovery of roads from spring softening does not occur until late summer, suggesting the need for WisDOT to review the current April-May time frame for removing spring thaw weight limits.

Implementation

WisDOT's Bureau of Highway Operations (BOH) used UWFROST during the '98 – '99 and '99 – '00 winter seasons and found the software's fall freezing and spring thawing projections to be quite accurate for normal winters.

WisDOT will continue to pilot the software in the central office and selected district offices for the next two winters. Actual pavement strength and damage data will be collected and compared to projections obtained from the computer model in order to make a judgment on how extensively to implement its use.

Potential Benefits

- A standardized approach to establishing frozen road declarations and imposing spring thaw weight restrictions will reduce costly damage to Wisconsin's roads and also save WisDOT staff time.
- Once proven, the model could serve to assure the public that WisDOT decisions are data-driven, based on field-proven engineering principles uniformly applied.
- Use of the model could allow more precise timing of weight limits in different parts of the state and to different types of pavement-base-subgrade roadways.